



Section 5: Underwater Robots

Introduction to Underwater Robots

The site characterization component of the *Okeanos Explorer* exploration strategy depends heavily upon remotely operated vehicles (ROVs; for more information about the *Okeanos Explorer* exploration strategy, please see Lesson 1, *To Explore Strange New Worlds*). These are unoccupied robots usually linked to a surface ship by a group of cables. Most ROVs are equipped with one or more video cameras and lights, and may also carry other equipment such as a manipulator or cutting arm, water samplers, equipment for collecting samples, and measuring instruments to expand the vehicle's capabilities for gathering data about the deep-ocean environment.

For her maiden voyage during the INDEX-SATAL 2010 Expedition, the NOAA Ship *Okeanos Explorer* carried *Little Hercules*, an ROV originally developed by a team of engineers at Dr. Robert Ballard's Institute for Exploration (IFE) at the University of Rhode Island for the primary purpose of gathering high quality video imagery. Nicknamed "*Little Herc*," the ROV proved to be well-suited to this purpose on

a variety of successful missions for IFE, including providing the first and only images of John Kennedy's PT Boat, *PT-109*. Eventually, a much larger ROV named "*Hercules*" took over these tasks, and *Little Herc* became part of an exhibit at the Mystic Aquarium. This shore duty came to an end, however, when it became clear that *Okeanos Explorer*'s primary ROV would not be ready in time for the INDEX-SATAL 2010 Expedition. Through a collaboration between IFE and NOAA's Office of Ocean Exploration and Research, *Little Herc* was brought out of retirement and refitted specifically to meet the expedition's needs.

Little Herc is operated in tandem with a camera platform that carries 2,400 watts of lighting provided by HMI (hydrargyrum medium-arc iodide) arc lamps. This lighting illuminates the total darkness of the deep ocean, helps guide *Little Hercules*, and provides lighting for the high-definition video images of the ROV at work. The camera platform is named *Seirios*, after the name of the brightest star in the night sky (also called the Dog Star, sometimes spelled "Sirius"). *Little Herc* is attached

Okeanos Explorer crew launch the vehicle during test dives off Hawaii. Image courtesy of NOAA *Okeanos Explorer* Program, INDEX-SATAL 2010.

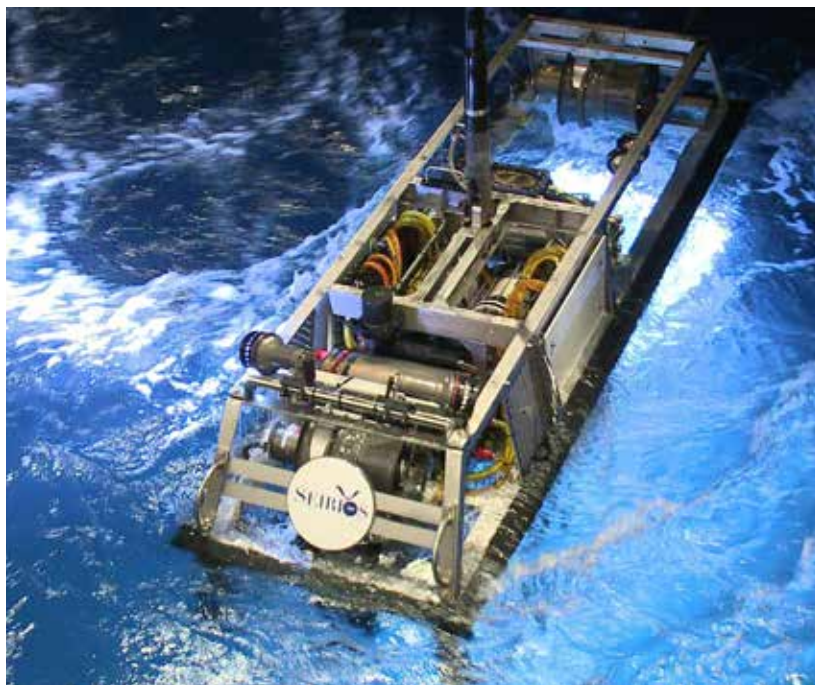
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to *Seirios* by a 30-m cable called the Remotely Operated Vehicle Tether, while the camera platform is attached to the *Okeanos Explorer*'s traction winch by a 17 mm Oceanographic Instrumentation and Control Cable which has an armored outer jacket with 3 power conductors and 3 optical fibers for transmitting data and control signals.

A variety of sensors are aboard the ROV for navigation and data collection. These include depth and altitude sensors, an Ultra Short Baseline Tracking System, full color imaging sonar, and a Seabird SBE 49 FastCAT CTD. Video equipment includes two Insite Pacific single CCD (charge-coupled device) high-resolution miniature color video cameras, one Insite Pacific triple CCD high-definition Zeus Plus video camera, two Deep Sea Power and Light 250-watt LED matrix lights, and two Deep Sea Power and Light 400-watt HMI arc lamps. For additional details about *Little Herc*, see the sidebar, The *Little Hercules* Remotely Operated Vehicle. For more information about other ROVs, visit <http://oceanexplorer.noaa.gov/technology/subs/subs.html>.

Lessons in this section introduce students to remotely operated vehicles and video imagery as they are used for ocean exploration aboard the *Okeanos Explorer*. Additional video imagery from other *Okeanos Explorer* voyages of discovery can be accessed from the *Okeanos Explorer* Web site (http://oceanexplorer.noaa.gov/okeanos/media/exstream/exstream_playlist.html).



The *Seirios* camera sled returns to the surface following a great day of work. Image courtesy of NOAA *Okeanos Explorer* Program, Galapagos Rift Expedition 2011.

http://oceanexplorer.noaa.gov/okeanos/explorations/ex1103/logs/hires/july22_update3_hires.jpg

The *Little Hercules* Remotely Operated Vehicle

Little Hercules was developed by a team of engineers at Dr. Robert Ballard's Institute for Exploration (IFE) at the University of Rhode Island. Its primary purpose is to gather high quality video imagery in support of scientific research and ocean exploration. Major systems include:

- **Power** – 2,800 volts (AC) supplied from the surface; stepped down to 120 VAC by a transformer aboard *Little Herc*
- **Propulsion** – Four Technadyne 1020 electric thrusters; two oriented horizontally to provide forward, backward, and rotational motion, and two mounted to form a V when viewed from the front which provides up, down, and lateral movement
- **Onboard Control** – PC104 computer
- **Imaging** – Main Camera: One Insite Pacific triple CCD high-definition Zeus Plus HDTV camera with zoom and macro; Utility Cameras: Two Insite Pacific single CCD high-resolution miniature color video cameras
- **Lighting** – Two Deep Sea Power and Light 250-watt-equivalent LED matrix lights; Two Deep Sea Power and Light 400-watt HMI arc lamps
- **Navigation** – Ultrashort Baseline acoustic transponder (works in concert with ship-based system that calculates the ROV's underwater position)
- **Sensors** – Paroscientific 8B7000 pressure/depth sensor; Seabird SBE 49 FastCAT CTD; Tritech PA500 altimeter; Tritech Super Seaking scanning sonar

These components are integrated within an aluminum frame that is supported in water by a flotation package of syntactic foam, which provides slightly positive buoyancy that is trimmed to neutral by the ROV's vertical thrusters. Most electronics are contained in a 10-inch diameter titanium pressure housing. The ROV is rated to a depth of 4,000 meters, and in air weighs 1,200 pounds.

Little Hercules is operated in tandem with a camera platform named *Seirios* that is equipped with a HD video camera identical to that on the ROV, as well as six HMI (hydrargyrum medium-arc iodide) arc lamps that provide a total of 2,400 watts of lighting. *Seirios* has no buoyancy module, and is intentionally much heavier than water to provide a buffer between the ROV and surface motion of the ship. *Little Hercules* is attached to *Seirios* by a 30-m cable called the Remotely Operated Vehicle Tether. *Seirios* is attached to the *Okeanos Explorer*'s traction winch by a 17 mm Oceanographic Instrumentation and Control Cable which has an armored outer jacket with 3 power conductors and 3 optical fibers for transmitting data and control signals. A traction winch has large diameter grooved drums that are designed to protect cables from excessive friction and bending under heavy load conditions.

Prior to every dive, the ROV crew reviews multibeam sonar maps of the proposed dive area, and develops a track-line that is the initial path that the ROV will follow. During a dive, the ROV pilots may modify the track-line as they receive requests from scientists aboard the ship and in Exploration Command Centers to obtain video images of certain features and organisms that the ROV encounters during its exploration.